

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Assistant Commissioner for Patents
United States Patent and Trademark
Office
Box PCT
Washington, D.C.20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year)

21 September 1999 (21.09.99)

International application No.

PCT/GB99/00405

Applicant's or agent's file reference

M98/0106/PCT

International filing date (day/month/year)

09 February 1999 (09.02.99)

Priority date (day/month/year)

18 February 1998 (18.02.98)

Applicant

HOWARTH, Paul, Graham et al

1. The designated Office is hereby notified of its election made:

☒

in the demand filed with the International Preliminary Examining Authority on:

26 August 1999 (26.08.99)

☐

in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

☐

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

C. Carrié

Telephone No.: (41-22) 338.83.38

TENT COOPERATION TREATY

PTO/PC 07 AUG 2000

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

From the INTERNATIONAL BUREAU

To:
McNEIGHT, David, Leslie
McNeight & Lawrence
Regent House
Heaton Lane
Stockport
Cheshire SK4 1BS
ROYAUME-UNI

Date of mailing (day/month/year) 26 August 1999 (26.08.99)		
Applicant's or agent's file reference M98/0106/PCT		IMPORTANT NOTICE
International application No. PCT/GB99/00405	International filing date (day/month/year) 09 February 1999 (09.02.99)	Priority date (day/month/year) 18 February 1998 (18.02.98)
Applicant POWER X LIMITED et al		

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
AU,CN,EP,IL,JP,KP,KR,US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,CA,CH,CU,CZ,DE,DK,EA,EE,ES,FI,GB,GD,GE,GH,GM,HR,HU, ID,IN,IS,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MD,MG,MK,MN,MW,MX,NO,NZ,OA,PL,PT,RO,RU,SD, SE,SG,SI,SK,SL,TJ,TM,TR,TT,UA,UG,UZ,VN,YU,ZW
The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on 26 August 1999 (26.08.99) under No. WO 99/43131

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer J. Zahra
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
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BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
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BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
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CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
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SCHEDULING MEANS FOR DATA SWITCHING APPARATUS

This invention relates to scheduling means for data switching apparatus for use in computer-controlled digital data switching systems.

Many types of data transmission apparatus are known, all having their own particular features and systems. In all cases the intention is to allow data switching and transmission to be achieved as rapidly as the apparatus will allow. It is common for data to be sent in "packets" consisting of a predetermined number of bits of data plus control information indicating certain parameters of the data or its mode of transmission.

In data switching apparatus having an number of users there may be a requirement at any one time to set up a number of different interconnections between input ports and output ports. In any form of switch there is a limit to the number of simultaneous interconnections that may be formed. The switch is operating at its greatest efficiency when the greatest possible number of interconnections is formed and switching apparatus frequently includes what may be termed "scheduling means" in order to achieve this maximum number of interconnections.

A good scheduling scheme needs to balance the potentially conflicting objectives of making sure that all output ports are connected where there are requests for a connection to that port (efficiency), that high priority traffic is serviced quickly (prioritisation) and that low priority traffic is not ignored (fairness). The present invention addresses all of these issues and may, for example, be used with the data switching apparatus described and claimed in our co-pending British patent application No. 9717412.2

Various types of scheduling means are known. For example, United States Patent No. 5,500,858 describes one form of scheduling means in which requests for interconnections are considered and satisfied using what are called "rotating priority iterative matching desynchronising scheduler units". The "priority" in this case refers to priority given to input and output ports at any given time so as to ensure that each port has a fair chance of having a connection requests satisfied. The U.S. Patent goes on to describe how the scheme could be extended to handle requests at multiple priority levels but the scheme described would lack fairness, that is low priority requests would be ignored

under heavy load conditions where only higher priority requests would be satisfied.

It is an object of the present invention to provide data switching apparatus which includes scheduling means operable to satisfy a greater number of requests for interconnections than has previously been possible under such circumstances.

According to the present invention there is provided scheduling means for data switching apparatus having a plurality of input ports and a plurality of output ports between which data having one of a predetermined number of priority levels is to be passed, which scheduling means includes a first pipeline stage operable to satisfy at least some of the requests for interconnections which are applied to the scheduling means, a priority mixer to which are applied those requests for interconnections which were not satisfied by the first pipeline stage together with requests of different priority levels and operable to select which of those requests should be further considered, and at least one further pipeline stage to which are applied said further requests and operable to satisfy such of those requests as are possible and were not satisfied by any preceding pipeline stage.

The present invention overcomes the problems associated with the known prior art by using existing types of scheduling units, (for example those described in U.S. Patents Nos. 5,500,858 and 5,267,235, though any scheduling means which operates as described herein may be used) but connecting them in a novel arrangement. The scheduling means to be described may, for example, be used with the data switching apparatus described and claimed in our co-pending British patent application No. 9717412.2.

The invention will now be described with reference to the accompanying drawing, which shows a schematic block diagram of one embodiment of the invention.

The drawing shows three pipeline stages 10 to 12, with a priority mixer 13 connected between pipeline stages 10 and 11. Input connections and output connections are provided to the various pipeline stages and the priority mixer as shown and the operation of the arrangement will be described below.

Each of the pipeline stages 10, 11 and 12 operates to receive input connection Request Vectors RV_i at Priority level P_i and a

Connection Vector CVi. In response to these inputs the pipeline stage generates output signals Queue Return QRet, Request Vector out RVo, Priority out Po and Connection Vector out CVo. The Request Vectors are bit fields where each bit corresponds to a possible connection between one of the input ports and one of the output ports of the data switching apparatus. That is, if there are n input ports and m output ports, the Request Vectors will be $n \times m$ bits wide, where a bit that is set indicates that a connection is being requested from the corresponding input port to the corresponding output port, whilst a bit that is clear indicates that such a connection is not being requested at this time. The Priority fields Pi and Po indicate the priority of the connection being requested at input (RVi) and output (RVo) respectively. The connection requests from each input port are all of the same priority, though the connections requested from different input ports may be of different priorities. The Connection Vector signal CVo defines connections which are to be made by a switching matrix (not shown). They indicate which input port, if any, is to be connected to each output port of the data switching apparatus. The Queue Return signals Qret represent connection requests that cannot be satisfied. These requests are returned to the input queues of the data switching apparatus ready to be requested again. The operation performed by each pipeline stage is to consider the connection requests at RVi and satisfy as many of them as possible, adding details of each satisfied connection to any already present at CVi and presenting the combined set of connections at CVo. Since each input port and each output port may only be involved in one connection at any given time, any connection requests which involve an input port or output port which is already part of a satisfied connection request may no longer be satisfied within the present set of connections and so such requests are returned to the input queues (signal Qret), to be considered as part of a subsequent set of connections. The remaining connection requests (those for which the corresponding input and output ports are still available for connection) are presented at the RVo output of the pipeline stage in order for them to be considered by a subsequent pipeline stage. Any such requests at the output of the last pipeline stage 13 (where there is no subsequent pipeline stage to consider them) are returned to the input queues of the data switching apparatus, as with the Qret output.

Consider now the overall operation of the scheduling means described above. At the input to the first pipeline stage, 10 requests for connections RV_i at a single priority level P_i are presented. The first pipeline stage 10 then attempts to satisfy as many of these requests as possible. Traffic of each priority level is presented to the first pipeline stage 10 at a frequency proportional to the required bandwidth allocation for that priority level. For example, high priority level requests could be presented 50% of the time if a 50% bandwidth allocation for high priority traffic was required. The proportions assigned to each priority level would depend on the application and would be assigned by the system administrator and be independent of the operation of the pipeline stage. A lookup table may be used to define the priorities for each priority level. If there is only a small number of requests at the priority P_i then the first pipeline stage 10 will not make many connections and most of the input and output ports will not be utilised within the set of connections created by this stage, nor will there be many connection requests outstanding at that priority level which may be satisfied by the remaining pipeline stages 11 and 12. For this reason, the priority mixer 13 is introduced between the first and second pipeline stages 10 and 11. Applied to priority mixer 13 are connection requests RV_{2i} of priorities other than P_i , the priorities of the requests being denoted by P_{2i} . The priority mixer 13 decides, for each input port, whether to pass on to the second pipeline stage 11 the requests RV_i remaining at priority level P_i from the first pipeline stage 10 or the new requests RV_{2i} . The decision is made on the basis of choosing whichever set of requests has the highest number of requests that could still be satisfied within the current Connection Vector CV_i , taking into account which input and output ports are already used by satisfied connection requests. This leads to higher connectivity within the data switching apparatus than if only requests of a single priority were considered, that is it is more efficient. It also allows good performance for low priority traffic in the absence of any higher priority traffic, since the low priority requests may be presented at the second pipeline stage 11 via the priority mixer 13, regardless of how infrequently low priority requests are selected to be presented to the first pipeline stage 10. The Connection Vector output CV_o of the

last pipeline stage 13 defines all the connections that are to be made by the data switching apparatus in the next cycle of operation.

Since mixing requests of different priorities at the second and subsequent stages of the scheduling means leads to greater efficiency, it might seem like a good idea to do the same at the first pipeline stage 10. However, the scheduling units that make up each pipeline stage

do not themselves take any account of the priority of each request, that is they treat all requests equally. Hence if requests of different priorities were presented to the first pipeline stage there would be no concept of priority at all within the scheduling means, since the low
5 priority requests would compete equally with the high priority requests for connections. Thus it will be seen that the first pipeline stage provides prioritisation and fairness as defined above, whilst the subsequent pipeline stages provide efficiency.

Further pipeline stages may be added if it is felt that three
10 stages are not able to provide sufficiently high efficiency of switch utilisation. There is a trade-off between switch utilisation (how many connection requests may be satisfied at any time) and latency (each pipeline stage takes time to operate), so that the number of pipeline stages required will depend upon what balance of these factors is
15 required for a particular embodiment. In general, more pipeline stages are needed to create maximal sets of connections as the number of ports in the data switching apparatus increases. In addition, priority mixer elements may be placed between others of the pipeline units to further increase efficiency if desired.

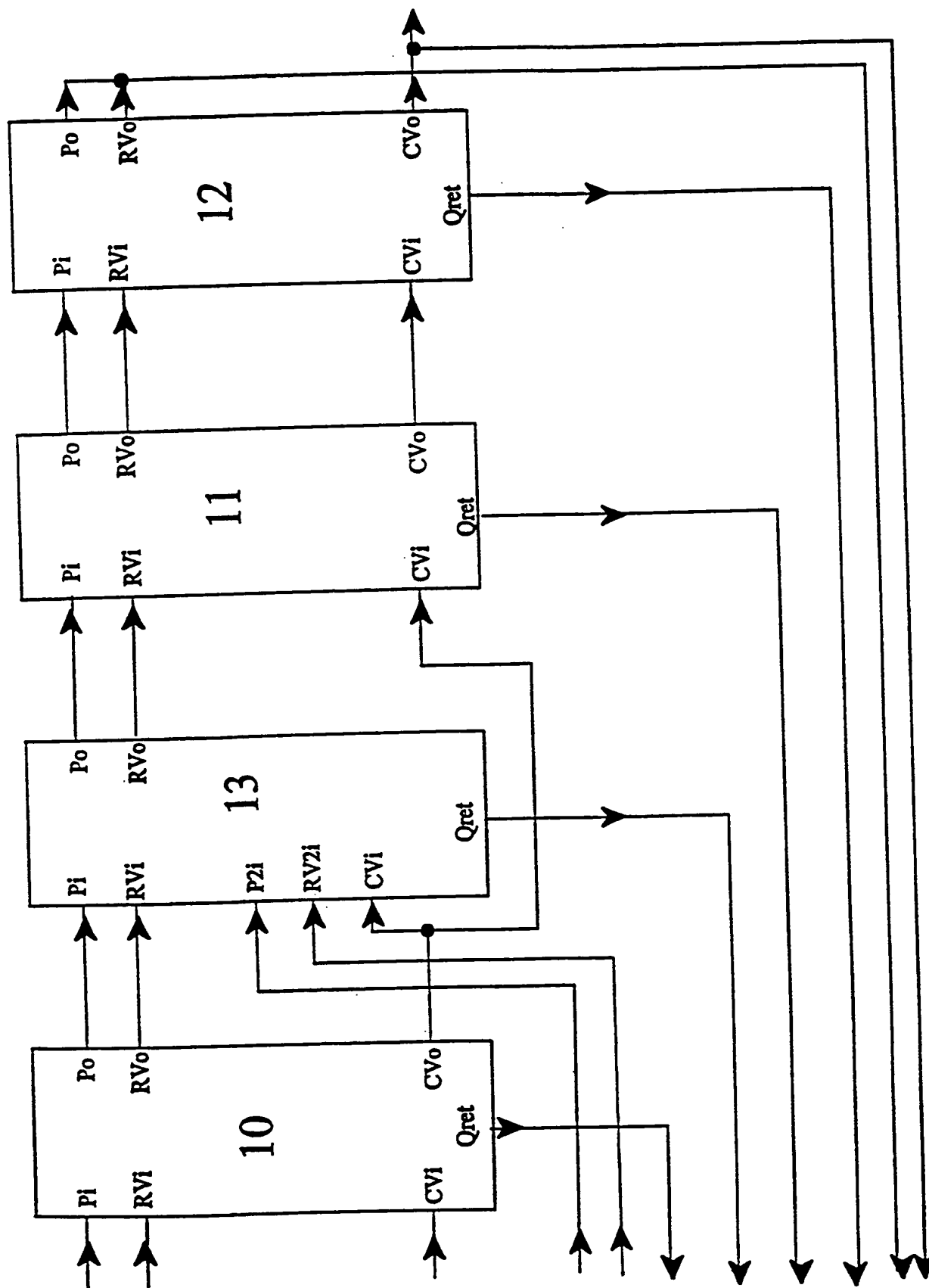
Instances may occur when, for example, certain connections between
20 input ports and output ports are to be retained for a period of time (static or permanent connections). Alternatively, it may be necessary at certain times to block specified input ports or output ports (during a period of system maintenance, for example). Similarly, it may be
25 necessary at certain times to set up connections from one input port to more than one output port at the same time (multicast). All of these facilities may be incorporated into data switching apparatus which uses the scheduling means described above. This is done by connecting appropriate logic to the inputs of the first pipeline stage 10 and/or
30 the priority mixer 13. For instance, to create a permanent connection between an input port and an output port, the CVi input of the first pipeline stage 10 could be preset to indicate the required connection(s) rather than having all of its bits clear (indicating no pre-existing connections). Input and output ports may be blocked by masking off the
35 appropriate bits of the RVi input of the first pipeline stage 10 and the RV2i input of the priority mixer 13. Multicast connections may be made in the same way as permanent connections, except that more than one

output port is set up to be connected to the desired input port. In all of these cases, the scheduling means works around the existing connections or blocked ports, making whatever connections it can between the remaining unconnected and non-blocked input and output ports.

CLAIMS

1. Scheduling means for data switching apparatus having a plurality of input ports and a plurality of output ports between which data having one of a predetermined number of priority levels is to be passed, which scheduling means includes a first pipeline stage operable to satisfy at least some of the requests for interconnections which are applied to the scheduling means, a priority mixer to which are applied those requests for interconnections which were not satisfied by the first pipeline stage together with requests of different priority levels and operable to select which of those requests should be further considered and at least one further pipeline stage to which are applied said further requests and operable to satisfy such of those requests as are possible and were not satisfied by any preceding pipeline stage.
2. Scheduling means as claimed in Claim 1 in which requests for interconnections applied to the first pipeline stage are all of the same priority level.
3. Scheduling means as claimed in either of Claims 1 or 2 in which priority mixers are inserted between any pairs of the pipeline stages.
4. Scheduling means as claimed in any one of Claims 1 to 3 in which different types of predetermined connections may be set up between some of the ports at the input to the scheduling means such that the scheduling means is free to set up connections only between the ports not so connected.
5. Scheduling means as claimed in any one of the preceding claims in which requests for connections to or from any of the input or output ports may be inhibited, thereby preventing any connections being made to or from those ports.
6. Scheduling means for data switching apparatus having a plurality of input ports and a plurality of output ports between which data having one of a predetermined number of priority levels is to be passed, substantially as herein described with reference to the accompanying drawing.

1 / 1



INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/00405

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04L12/56 H04Q11/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 126 999 A (MUNTER ERNST A ET AL) 30 June 1992	1-3,6
A	see column 4, line 66 - column 5, line 41 see column 6, line 19 - column 7, line 54	4,5
A	US 5 500 858 A (MCKEOWN NICHOLAS W) 19 March 1996 cited in the application see column 4, line 17 - column 5, line 28	1-6

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

2 July 1999

Date of mailing of the international search report

12/07/1999

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Meurisse, W

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 99/00405

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5126999 A	30-06-1992	CA 1320257 A	13-07-1993
US 5500858 A	19-03-1996	NONE	

Continuation of Form PCT/IB/308

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF
THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

Date of mailing (day/month/year) 26 August 1999 (26.08.99)	IMPORTANT NOTICE
Applicant's or agent's file reference M98/0106/PCT	International application No. PCT/GB99/00405
<p>The applicant is hereby notified that, at the time of establishment of this Notice, the time limit under Rule 46.1 for making amendments under Article 19 has not yet expired and the International Bureau had received neither such amendments nor a declaration that the applicant does not wish to make amendments.</p>	

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference M98/0106/PCT	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/GB 99/ 00405	International filing date (day/month/year) 09/02/1999	(Earliest) Priority Date (day/month/year) 18/02/1998
Applicant POWER X LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☐ as suggested by the applicant.

☒ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1

☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

CT/GB 99/00405

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04L12/56 H04Q11/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 126 999 A (MUNTER ERNST A ET AL) 30 June 1992	1-3,6
A	see column 4, line 66 - column 5, line 41 see column 6, line 19 - column 7, line 54 ---	4,5
A	US 5 500 858 A (MCKEOWN NICHOLAS W) 19 March 1996 cited in the application see column 4, line 17 - column 5, line 28 -----	1-6

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

& document member of the same patent family

Date of the actual completion of the international search

2 July 1999

Date of mailing of the international search report

12/07/1999

Name and mailing address of the ISA

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Fax: (+31-70) 340-3016

Authorized officer

Meurisse, W

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

CT/GB 99/00405

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5126999	A	30-06-1992	CA 1320257 A	13-07-1993
US 5500858	A	19-03-1996	NONE	

PATENT COOPERATION TREATY

PCT

REC'D 24 MAY 2000

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference M98/0106/PCT		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB99/00405	International filing date (day/month/year) 09/02/1999	Priority date (day/month/year) 18/02/1998	
International Patent Classification (IPC) or national classification and IPC H04L12/56			
Applicant POWER X LIMITED et al.			

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.


2. This REPORT consists of a total of 5 sheets, including this cover sheet.

- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 26/08/1999	Date of completion of this report 22.05.2000
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Kappatou, E Telephone No. +49 89 2399 7521



**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB99/00405

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-7 as originally filed

Claims, No.:

1-8 as received on 14/02/2000 with letter of 11/02/2000

Drawings, sheets:

1/1 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB99/00405

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims 1-8
	No: Claims
Inventive step (IS)	Yes: Claims 1-8
	No: Claims
Industrial applicability (IA)	Yes: Claims 1-8
	No: Claims

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The subject-matter of claim 1 is new and involves an inventive step, Art. 33(2)(3):
 - 1.1 Claim 1 relates to scheduling means for data switching apparatus, with a plurality of inputs and outputs, where each interconnection request to be scheduled has one of a predetermined number of priority levels. A first set of the requests, determined according to their priority, is received at the first pipeline stage, where some of the requests are satisfied.
 - 1.2 Such a scheduling means is known from document D1: US 5 500 858, which is cited in the application.
 - 1.3 The problem to be solved by the current application is to maximise the number of requests satisfied in each cycle, and at the same time to keep the priority of the data in consideration, in such a way, that even low priority data have a fair chance to be scheduled.
 - 1.4 This is achieved by having the requests not satisfied by the first pipeline stage, together with requests of any priority level applied to a priority mixer, which selects which of those requests are to be considered. The selected requests are applied to the further pipeline stage, which satisfies the possible ones from the selected requests.
2. This solution cannot be derived from the prior art.
 - 2.1 Document D1 refers to a system that rotates the dynamical priorities of the ports, so that they all get a chance. The solution proposed leads away, because only one pipeline is suggested and because for each cycle, the requests are treated strictly according to the rotating priority.
 - 2.2 Document D2: US 5 126 999 discloses a scheduling system that also aims to maximise the requests satisfied in each cycle, but without considering the

priorities of the requests, or the fairness to the low priorities, which is achieved by priority mixing. Document D2 proposes, that the input port with most requests waiting in its FIFO queue, shall dynamically get the highest priority for each cycle. The priorities are, in this case, set in such a way, that the data do not fill the FIFO queues. In the contrary, in claim 1 of the current application, they refer to the predetermined priority level of the interconnection request itself.

3. Claims 2 to 8 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Re Item VII

Certain defects in the international application

1. The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.
2. The features of the claim are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).
3. The British Patent Application mentioned in page 1, line 25 of the description is not identified by the corresponding publication number.

Re Item VIII

Certain observations on the international application

1. The term "a priority level (Pi) which **has** one of a predetermined number of priority levels" in claim 1, line 8, is unclear, Article 6, PCT. It is implied that a priority level has itself priority levels.
2. Apparatus claim 8 contains method step "upon receiving ... **modifies**" and is therefore not clear concerning the category, Article 6, PCT.

14 00 00

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CLAIMS

1. Scheduling means for data switching apparatus having a plurality of input ports and a plurality of output ports, the scheduling means
5 being for processing a plurality of interconnection requests, each request requesting interconnection between a subset of said input ports and a subset of respective said output ports, and each request being associated with a priority level (Pi) which has one of a predetermined number of priority levels;

the scheduling means comprising:

10 determination means for determining a first set of said requests according to said respective priority levels; and

a first pipeline stage (10) for receiving said first set of requests and satisfying at least some of the first set of requests;

and characterized by further comprising:

15 priority mixer means (13) for determining a further set of said requests, the further set being composed of those requests of said first set which were not satisfied, and of requests among said plurality of requests which were not part of said first set and which are of any of said priority levels; and

20 an additional pipeline stage (11) for identifying requests in said further set which can be satisfied, and for satisfying the identified requests.

2. Scheduling means according to claim 1 in which said determination means at any time determines said first set of requests to have the same priority level, which is a selected priority level.

3. Scheduling means according to claim 2 in which the determination means varies the selected priority level with time, the proportion of time for which the selected priority level takes each of said predetermined number of priority levels being according to a respective predetermined proportion.

4. Scheduling means according to claim 1, claim 2 or claim 3 further comprising a further pipeline stage (12) receiving the requests not satisfied by the additional pipeline stage (11), or a plurality of successive further pipeline stages, the first of the successive further pipeline stages receiving the requests not satisfied by the additional pipeline stage (11), and each of the other successive further pipeline stages receiving the requests not satisfied by the preceding further pipeline state.

5. Scheduling means according to claim 4 further comprising priority mixing means provided before any of said further pipeline stages, for transmitting to that further pipeline stage additional ones of said requests which have not been satisfied.

6. Scheduling means according to any preceding claim which employs a data array (CV_i , CV_o) defining connections, said pipeline stage satisfying said requests by modifying said data array.

7. Scheduling means according to claim 6 in which, upon receiving instructions specifying predetermined connections between some of the ports, said data array (CV_i) is modified to include said predetermined connections, whereby said pipeline stages only satisfying requests which are consistent with said predetermined connections.

8. Scheduling means according to any preceding claim, further comprising means which, upon receiving instructions to inhibit connections to or from any of the input or output ports, modifies the inputs to the first pipeline stage and priority mixer to prevent connections to or from said inhibited ports.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 99/00405

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H04L 12/56 H04011/04

07 AUG 2000

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 126 999 A (MUNTER ERNST A ET AL) 30 June 1992	1-3,6
A	see column 4, line 66 - column 5, line 41 see column 6, line 19 - column 7, line 54	4,5
A	US 5 500 858 A (MCKEOWN NICHOLAS W) 19 March 1996 cited in the application see column 4, line 17 - column 5, line 28	1-6

☐

Further documents are listed in the continuation of box C.

☒

Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

2 July 1999

Date of mailing of the international search report

12/07/1999

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Meurisse, W

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 99/00405

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5126999 A	30-06-1992	CA 1320257 A	13-07-1993
US 5500858 A	19-03-1996	NONE	

PATENT COOPERATION TREATY

07 AUG 2000

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference M98/0106/PCT		See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) FOR FURTHER ACTION	
International application No. PCT/GB99/00405	International filing date (day/month/year) 09/02/1999	Priority date (day/month/year) 18/02/1998	
International Patent Classification (IPC) or national classification and IPC H04L12/56			
Applicant POWER X LIMITED et al.			


1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

 These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 26/08/1999	Date of completion of this report 22.05.2000
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Kappatou, E Telephone No. +49 89 2399 7521



INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB99/00405

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-7 as originally filed

Claims, No.:

1-8 as received on 14/02/2000 with letter of 11/02/2000

Drawings, sheets:

1/1 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/GB99/00405

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims 1-8
	No: Claims
Inventive step (IS)	Yes: Claims 1-8
	No: Claims
Industrial applicability (IA)	Yes: Claims 1-8
	No: Claims

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The subject-matter of claim 1 is new and involves an inventive step, Art. 33(2)(3):
 - 1.1 Claim 1 relates to scheduling means for data switching apparatus, with a plurality of inputs and outputs, where each interconnection request to be scheduled has one of a predetermined number of priority levels. A first set of the requests, determined according to their priority, is received at the first pipeline stage, where some of the requests are satisfied.
 - 1.2 Such a scheduling means is known from document D1: US 5 500 858, which is cited in the application.
 - 1.3 The problem to be solved by the current application is to maximise the number of requests satisfied in each cycle, and at the same time to keep the priority of the data in consideration, in such a way, that even low priority data have a fair chance to be scheduled.
 - 1.4 This is achieved by having the requests not satisfied by the first pipeline stage, together with requests of any priority level applied to a priority mixer, which selects which of those requests are to be considered. The selected requests are applied to the further pipeline stage, which satisfies the possible ones from the selected requests.
2. This solution cannot be derived from the prior art.
 - 2.1 Document D1 refers to a system that rotates the dynamical priorities of the ports, so that they all get a chance. The solution proposed leads away, because only one pipeline is suggested and because for each cycle, the requests are treated strictly according to the rotating priority.
 - 2.2 Document D2: US 5 126 999 discloses a scheduling system that also aims to maximise the requests satisfied in each cycle, but without considering the

priorities of the requests, or the fairness to the low priorities, which is achieved by priority mixing. Document D2 proposes, that the input port with most requests waiting in its FIFO queue, shall dynamically get the highest priority for each cycle. The priorities are, in this case, set in such a way, that the data do not fill the FIFO queues. In the contrary, in claim 1 of the current application, they refer to the predetermined priority level of the interconnection request itself.

3. Claims 2 to 8 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Re Item VII

Certain defects in the international application

1. The description is not in conformity with the claims as required by Rule 5.1(a)(iii) PCT.
2. The features of the claim are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).
3. The British Patent Application mentioned in page 1, line 25 of the description is not identified by the corresponding publication number.

Re Item VIII

Certain observations on the international application

1. The term "a priority level (Pi) which **has** one of a predetermined number of priority levels" in claim 1, line 8, is unclear, Article 6, PCT. It is implied that a priority level has itself priority levels.
2. Apparatus claim 8 contains method step "upon receiving ... **modifies**" and is therefore not clear concerning the category, Article 6, PCT.

*Rec'd 20 AUG 00*CLAIMS

1. Scheduling means for data switching apparatus having a plurality of input ports and a plurality of output ports between which data having one of a predetermined number of priority levels is to be passed, which scheduling means includes a first pipeline stage operable to satisfy at least some of the requests for interconnections which are applied to the scheduling means, a priority mixer to which are applied those requests for interconnections which were not satisfied by the first pipeline stage together with requests of different priority levels and operable to select which of those requests should be further considered and at least one further pipeline stage to which are applied said further requests and operable to satisfy such of those requests as are possible and were not satisfied by any preceding pipeline stage.
2. Scheduling means as claimed in Claim 1 in which requests for interconnections applied to the first pipeline stage are all of the same priority level.
3. Scheduling means as claimed in either of Claims 1 or 2 in which priority mixers are inserted between any pairs of the pipeline stages.
4. Scheduling means as claimed in any one of Claims 1 to 3 in which different types of predetermined connections may be set up between some of the ports at the input to the scheduling means such that the scheduling means is free to set up connections only between the ports not so connected.
5. Scheduling means as claimed in any one of the preceding claims in which requests for connections to or from any of the input or output ports may be inhibited, thereby preventing any connections being made to or from those ports.
6. Scheduling means for data switching apparatus having a plurality of input ports and a plurality of output ports between which data having one of a predetermined number of priority levels is to be passed, substantially as herein described with reference to the accompanying drawing.

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

LAWRENCE, John Gordon
McNeight & Lawrence
Regent House, Heaton Lane
Stockport, Cheshire, SK4 IBS
GRANDE BRETAGNE

NOTIFICATION OF RECEIPT OF DEMAND BY COMPETENT INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

(PCT Rules 59.3(e) and 61.1(b), first sentence
and Administrative Instructions, Section 601(a))

PTO/PCT Rec'd 07 AUG 2000

Date of mailing
(day/month/year)

16. 09. 99

Applicant's or agent's file reference
M98/0106/PCT

IMPORTANT NOTIFICATION

International application No.

PCT/GB 99/ 00405

International filing date (day/month/year)

09/02/1999

Priority date (day/month/year)

18/02/1998

Applicant

POWER X LIMITED et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority considers the following date as the date of receipt of the demand for international preliminary examination of the international application:

26/08/1999

2. This date of receipt is:

- ☒ the actual date of receipt of the demand by this Authority (Rule 61.1(b)).
☐ the actual date of receipt of the demand on behalf of this Authority (Rule 59.3(e)).
☐ the date on which this Authority has, in response to the invitation to correct defects in the demand (Form PCT/IPEA/404), received the required corrections.

3. ☐ **ATTENTION:** That date of receipt is **AFTER** the expiration of 19 months from the priority date. Consequently, the election(s) made in the demand does (do) not have the effect of postponing the entry into the national phase until 30 months from the priority date (or later in some Offices) (Article 39(1)). Therefore, the acts for entry into the national phase must be performed within 20 months from the priority date (or later in some Offices) (Article 22). For details, see the *PCT Applicant's Guide*, Volume II.

- ☐ (If applicable) This notification confirms the information given by telephone, facsimile transmission or in person on: _____

4. Only where paragraph 3 applies, a copy of this notification has been sent to the International Bureau.

Name and mailing address of the IPEA/



European Patent Office
D-80298 Munich
Tel. (+ 49-89) 2399-0, Tx: 523656 epmu d
Fax: (+ 49-89) 2399-4465

Authorized officer

Martina Nilsson

Telephone No.

- 88 56

PATENT COOPERATION TREATY

PTO/PCT Rec'd 07 AUG 2000
PCT

From the INTERNATIONAL BUREAU

NOTIFICATION CONCERNING
SUBMISSION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

McNEIGHT, David, Leslie
McNeight & Lawrence
Regent House
Heaton Lane
Stockport
Cheshire SK4 1BS
ROYAUME-UNI

Date of mailing (day/month/year) 05 May 1999 (05.05.99)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference M98/0106/PCT	
International application No. PCT/GB99/00405	
International publication date (day/month/year) Not yet published	
Applicant POWER X LIMITED et al	International filing date (day/month/year) 09 February 1999 (09.02.99) Priority date (day/month/year) 18 February 1998 (18.02.98)

- The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
- This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
- An asterisk(*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
- The letters "NR" appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
18 Febr 1998 (18.02.98)	9803301.2	GB	03 May 1999 (03.05.99)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Carlos Naranjo

CAN

Telephone No. (41-22) 338.83.38